

Onboard Systems Record Unique Videos of Space Missions

Originating Technology/NASA Contribution

It was one of the few times that a crash landing would be deemed a success. On October 9, 2009, nine sensor instruments—including five cameras—onboard the Lunar Crater Observation and Sensing Satellite (LCROSS) watched closely as the Moon-bound spacecraft released the spent upper stage of its Centaur launch vehicle at the lunar surface. The instrument-bearing shepherding spacecraft beamed back video of the Centaur's impact and then descended through the resulting plume, gathering data on the composition of the ejected material until it too impacted within the lunar crater Cabeus. The mission yielded a wealth of information confirming what scientists had hoped for: the presence of water on the Moon.

A specially designed avionics unit controlled, routed, and transmitted back to Earth the precious data gathered from all of LCROSS' onboard instruments. The crucial control unit was the outcome of a collaboration between

NASA's Ames Research Center and a unique company whose products have benefited from this and other NASA partnerships.

Partnership

In 1999, a company called BlastOff! Corporation was formed in Pasadena, California, with the intent of landing the first commercial robotic lander, equipped with a host of onboard video and imaging systems, on the Moon. The company folded in 2001, but a group of BlastOff! employees went on to form [Ecliptic Enterprises Corporation](#), also of Pasadena, to take advantage of the expertise they developed in creating ruggedized video systems for use in space.

Onboard video systems for rockets or spacecraft provide stunning footage of launches and space activities—valuable material for educating and inspiring interest in space exploration. But another significant benefit is the essential information these video feeds provide to engineers on the ground. While casual viewers get to

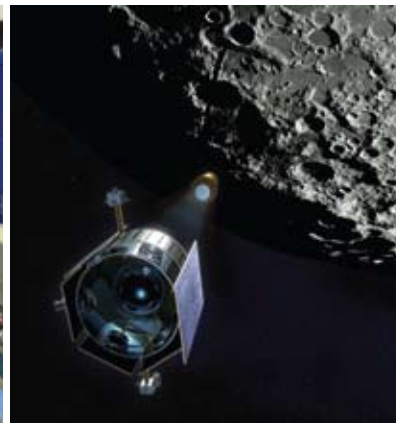
experience a virtual ride into space, watching the Earth fall away under a rocket's flames, engineers gain important situational awareness, allowing them to monitor and evaluate a rocket launch or the activity of a complicated mechanical device on a spacecraft.

The need for comprehensive situational awareness became readily apparent in the aftermath of the Columbia disaster. The Space Shuttle Columbia broke up while reentering Earth's atmosphere during its 2003 mission, killing its seven crewmembers. Investigators concluded the shuttle's destruction was caused by hot gasses entering through a hole in the thermal protection of the vehicle's left wing; the hole was caused by the impact of a chunk of foam insulation that broke away from the shuttle's external fuel tank during launch.

Seeking ways to improve situational awareness for future shuttle launches, NASA examined the use of multiple onboard cameras. On the STS-114 Return to Flight mission, Ecliptic's external tank camera captured the breakaway of a large piece of insulating foam, an incident which again grounded the shuttle fleet for nearly a year until the problem could be resolved. Of the multiple cameras trained on the shuttle during the launch, only Ecliptic's onboard camera provided the precise time the foam broke away from the tank, says company CEO and former Jet Propulsion Laboratory engineer Rex Ridenoure.

"The value of onboard video for situational awareness really got a boost in the aftermath of the Columbia tragedy," he says. Now the shuttle features multiple camera systems mounted on the external tank and on the solid rocket boosters.

Ecliptic RocketCam systems were incorporated into multiple other NASA missions—including the Delta II rockets for the 2003 twin Mars Exploration Rover missions and on the Demonstration of Autonomous Rendezvous Technology (DART) spacecraft in 2005—before the company signed a Memorandum of Understanding with Ames in 2007 to collaborate on



The science payload panel (left) for LCROSS (in the artist rendering above) underwent final testing at Ames Research Center in late 2007. The Data Handling Unit built by Ecliptic Enterprises Corporation is the gold box near the center.

Image courtesy of Ecliptic Enterprises Corporation

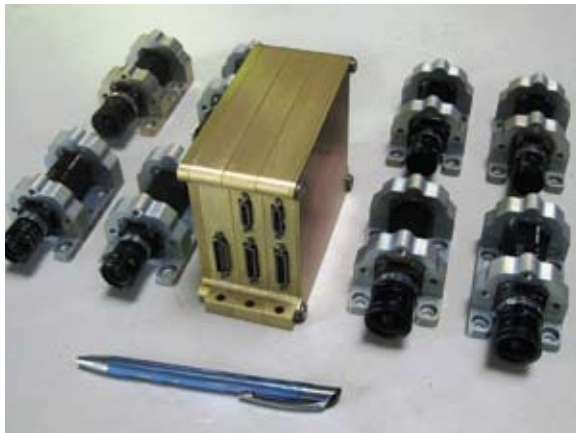


Image courtesy of Ecliptic Enterprises Corporation

Smaller, more capable RocketCam Digital Video Systems such as this will be used onboard future NASA, commercial, and defense rockets and spacecraft.

projects for onboard imaging systems and related technologies. As part of this collaboration, Ecliptic opened a small office in the Ames-based NASA Research Park.

Ecliptic became involved in the LCROSS mission when Ames principal investigator Anthony Colaprete realized the company's digital video controller—the avionics unit of its RocketCam Digital Video System (DVS) technology—could serve as the core technology for the spacecraft's Data Handling Unit, providing cost-effective control capabilities for its sensors.

"Up until this time, our video controllers were only controlling video cameras and other imaging sensors," says Ridenoure. "LCROSS wanted us to control several other sensors we had never seen, with lots of switching between them, lots of data formatting." The demands of the LCROSS mission required Ecliptic to develop a controller capable of handling higher data rates, more frequent sensor switching, and more data formatting complexities than its previous systems.

"LCROSS helped us push the capabilities of these digital video controllers and set us up to start tackling high-speed and high-definition video," Ridenoure says.

Ecliptic was able to advance its technology even further following the successful LCROSS mission. The company collaborated with NASA's Dryden Flight Research Center to develop a high-speed video system for monitoring the parachute deployments for the Constellation Abort Flight Test program, designed to test a launch abort system for the Orion crew capsule. Ridenoure says Ecliptic's work with Dryden developed the company's high-speed video capabilities and primed its technology for high-definition applications, since high-speed and high-definition share similar data rates.

Product Outcome

To date, Ecliptic's analog and digital RocketCam systems have been employed on more than 80 rocket launches and spacecraft missions for customers including NASA, the U.S. Department of Defense, and multiple aerospace companies. The company's technology has captured unique perspectives of an array of rocket launches, including Delta IIs, IIIs, and IVs; Atlas IIs, IIIs, and Vs; Titan IVs; and Minotaur Is and IVs. Ecliptic video systems also allowed the world to share the experience of Scaled Composite's SpaceShipOne aircraft making the first-ever privately funded human space flight. The company's systems are part of launches roughly every 4 to 6 weeks—with 8 to 12 in a typical year.

Ecliptic does not manufacture cameras, but rather takes off-the-shelf sensors, ruggedizes them to withstand the extreme conditions of launches and space operations, and houses them in protective pods and other enclosures that are affixed to the rocket or spacecraft. The company's key technology is its digital video controller, which is why Ridenoure is quick to note that Ecliptic is not a "camera company."

"Ninety percent of what we do is avionics, sensor-handling, and data switching, like what we did for LCROSS," he says.

Thanks to the company's work on the LCROSS mission and the Abort Flight Test program, Ecliptic has

gained not only desirable technical capabilities but also caché among commercial spacecraft developers.

"From a commercialization angle, it's largely because our systems were baselined and approved for various challenging NASA missions that commercial satellite programs have confidence in our systems for their spacecraft," Ridenoure says. Ecliptic systems with "lots of heritage with the one we had on LCROSS" are now on geosynchronous commercial satellites. The company has also generated a preliminary design for a high-definition video system based on the experience it gained from its Ames and Dryden work and anticipates its first sale in this category within the next year.

As NASA and commercial space partners develop new vehicles for traveling into low Earth orbit and beyond, Ecliptic expects to provide the video footage that will keep engineers apprised and the public in awe. Ecliptic systems are set to be incorporated on the Orbital Sciences Cygnus vehicle and Taurus II rocket, designed to ferry cargo to the International Space Station (ISS) as part of the Commercial Orbital Transportation Services program. This year, the company received its largest contract ever to supply the United Space Alliance with RocketCam DVS technology for solid rocket boosters on future NASA launch vehicles.

Ecliptic will also enable a major educational and public outreach project when it launches onboard the two Gravity Recovery and Interior Laboratory (GRAIL) spacecraft, set to map the gravitational field of the Moon in late 2011. MoonKAM (Moon Knowledge Acquired by Middle School Students) will be composed of Ecliptic video systems on each spacecraft and is sponsored by Sally Ride Science, led by the former astronaut who also initiated the ISS EarthKAM. Students will be able to schedule video recordings and retrieve the clips from NASA's datastream for educational activities, hopefully inspiring a new generation of space explorers. ♦

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